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NOTES ON THE EFFECT OF MAGNESIUM
ON PROCESSING

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NOTES ON THE EFFECT OF MAGNESIUM ON PROCESSING

By J. Weisman

This memo reports the results of a number of experiments involving magnesium. Although only preliminary results have been obtained, it is felt that they should be placed on record.

I - Effect of Magnesium on the Solubility of Uranium in Bismuth

The effect of magnesium on uranium solubility at 500°C was investigated. Initial runs were made as follows: Approximately 10 grams of purified bismuth, 1 gm of uranium plus the required amount of magnesium were placed above a coarse pyrex frit. The bismuth was melted under high vacuum, equilibrated at 500°C, and then filtered by application of helium pressure.

This procedure was not satisfactory because the magnesium reacted with glass. To prevent this, a graphite cup was inserted in the tube above the frit. To prevent bypassing of gas in filtration the glass was shrunk around the graphite. Holes which were small enough to retain the bismuth until gas pressure was applied, were drilled in the bottom of the cup. The molten metal was thus in contact with glass only for the few seconds required for filtration.

Using the graphite sleeves the data shown in fig. 1 were obtained. It is seen that magnesium has a small but appreciable effect on uranium solubility. More data should be obtained, particularly at low magnesium concentrations.

II - Reduction of Uranium and Thorium Compounds by Magnesium

The presence of large quantities of uranium oxide in Loop C, despite the addition of magnesium, indicates that at 500°C magnesium does not reduce UO_2 . ThO_2 also appears stable with respect to magnesium.

In one experiment Th and U were oxidized into the salt phase by adding $LiOH$ to the salt. This salt was then contacted with bismuth containing 4900 ppm Mg. Although there were 930 ppm of U and 430 ppm of Th in the salt, no more than 10 ppm of U and Th were detected in the metal.

In contrast to this, the chlorides of U and Th are reduceable. The results of two runs are given below. With 54 ppm of Mg in the metal, only a slight reduction is obtained. However, with 450 ppm of Mg, good reduction is obtained. Furthermore, the reduction of uranium proceeded to a far greater extent than that of thorium. In this run a separation factor of about 22 was obtained. It may be possible to base a blanket processing scheme on the selective reduction of uranium and thorium chlorides.

TABLE I

<u>Run No.</u>	<u>Procedure</u>	<u>Results</u>	
		<u>Bismuth</u>	<u>Salt</u> ($LiCl$) (KCl)
787	Th and U present in salt as oxides or hydroxides. Salt then contacted with bismuth containing magnesium.	40 ppm U 10 ppm Th 4900 ppm Mg	930 ppm U 430 ppm Th
907	{ Th and U added to salt as chlorides. Salt then contacted with Bi containing Mg.	1,060 ppm Th	2,250 ppm Th
		1,600 ppm U	157 ppm U
		450 ppm Mg	
920		60 ppm U 47 ppm Th 54 ppm Mg	230 ppm U 280 ppm Th

III - The Reduction of Rare Earth Chlorides

If the molten salt is thrown away after it is used for fission product extraction, its cost may be a considerable item. A cheap method of recovery and reuse of the salt would thus appear desirable.

Previous experiments have shown that the rare earths may be extracted from the salt into molten bismuth by adding Mg to the metal. Since, in this case the bismuth acts only as an inert carrier, it should be possible to substitute lead for it. This will, of course, result in a considerable saving as the price of lead is less than 1/10 that of bismuth.

Preliminary experiments have been carried out by J. Speirs using mixtures of lead and bismuth. Cerium was first transferred into the salt by contacting the salt with molten Bi containing Ce metal. The salt was then removed and contacted with a molten Pb - Bi alloy containing Mg. The results obtained are as follows:

TABLE II

<u>Run No.</u>	<u>PPM Ce in Metal</u>	<u>PPM Ce in Salt</u>	<u>Mg added to metal initially</u>	
982	67.7	141	500 ppm	} Mg analysis of metal after filtration and contact not available. Final value probably much less than that added.
983	64.7	171	1000 ppm	
984	62.7	147	1000 ppm	

The results obtained indicate that cerium can be transferred to lead. They of course do not establish the capacity of the lead for fission products since the runs were carried out at low reductant concentrations. The capacity should be quite large since it is not necessary to retain the fission products in solution. If a large excess of reductant is used, the fission products should be extracted from the salt after their solubility in the metal is exceeded. The limiting concentration would probably be set by heat removal considerations.

Further experiments should be run using much larger excesses of the reducing agent. Both calcium and magnesium should be tried.

IV - Use of Variable Oxidation Potential in Fuel Processing Scheme

Several chemical processing loops are now being planned by the Fuel Processing Group. In order to intelligently develop pumps, instrumentation and other components it is necessary to have some idea of the size of equipment which might eventually be used in an LMFR. A preliminary flow sheet has therefore been drawn up.

The flow sheet proposed in fig. 2, has used as a design basis those parameters developed by O. E. Dwyer in EML D-2820. The flow sheet differs from that shown in D-2820 in that a closed salt cycle is used. It was also assumed that it was desirable to operate all columns continuously. This limits the minimum flow rate of any stream to about 1/20 of a gpm, (smallest flow in D-2820 was 1/5 gal/hr). The use of larger flows necessitated the addition of another uranium stripping column in order to avoid excessive U losses.

Fig. 1

Effect of Magnesium on the
Solubility of Uranium in Bi

Temp - 500°C

% Uranium in Bi

% Magnesium in Bi



